Factors Affecting Knowledge Transfer in IT Projects

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Abstract: This article presents empirical research studying factors affecting knowledge transfer in information technology (IT) projects. The factors evaluated in this research include information technology, systems and procedures, and culture. The various dimensions of IT project success include project performance, project outcome, system implementation, benefits for the client organization, and benefits for the stakeholders. A survey conducted in Norway collected data on knowledge transfer and project success. Research results show that total project success relates to the extent of culture for effective knowledge transfer.

Keywords: Knowledge Transfer, Information Technology, Systems and Procedures, Culture, Project Success Criteria

EMJ Focus Areas: Knowledge & Information Management, Program & Project Management

There is growing recognition in the business community that knowledge is a critical resource for organizations and projects (Alavi and Leidner, 1999; Hansen et al., 1999; Zack, 1999). Traditionally, this resource has not been treated with the degree of systematic, deliberate, or explicit effort devoted to managing human, material, and financial resources. But in the coming years, the organization that leaves knowledge to its own devices may be placing itself in serious jeopardy. More and more practitioners and researchers believe that knowledge resources matter more than conventional resources (material, labor, capital, etc.) and must be managed explicitly, not left to fend for themselves (Holsapple and Joshi, 2000).

Project management is increasingly used to manage many tasks and functions within the IT department (Sauer et al., 2001). A *project* can be defined as "a one-shot, time-limited, goal-directed, major undertaking, requiring the commitment of varied skills and resources" (Meredith and Mantel, 2000). The IT project may be the design, development, and implementation of a new product, service, or process. According to Kasvi et al. (2003), successful project completion is based on accumulated knowledge and individual and collective competence. However, knowledge management in a project management context faces many challenges. Projects differ substantially from one another and significant discontinuities occur in personnel, material, and information flows. Frequently, personnel changes occur during the project, involving personnel with diverse backgrounds, cultures, and languages. Projects become temporarily limited and the people involved are often dispersed when the project ends. It becomes difficult to develop steady routines that maximize knowledge flow and capture learning, both within a project and from one project to the next. Creating, transferring, and sharing knowledge is a central challenge. In this article, we focus on knowledge transfer in IT projects. More specifically, we explore how knowledge transfer is affected by developing IT, systems and procedures, and culture in organizations. IT supports rapid collection, collation, storage, and dissemination of data, thereby facilitating the knowledge transfer process (Roberts, 2000; Garavelli et al., 2002). Systems and procedures describe the methods and phases in the knowledge transfer process (Seng et al., 2002). An organization's culture combines shared history, attitudes, expectations, unwritten rules, and social norms that affect the knowledge transfer process (De Long and Fahey, 2000; McDermott and O'Dell, 2001).

While earlier debates on knowledge management tended to revolve around using information and communication technologies and procedures, attention is increasingly extended to examining the role of social structures and cultures in promoting or inhibiting knowledge transfer (Bresnen et al., 2003). This raises the question of whether successful knowledge transfer depends on social and cultural aspects, rather than technological or procedural mechanisms. To answer this, we address the following research question: *What factors affect knowledge transfer in IT projects?* Few prior or related studies of factors promoting or inhibiting knowledge transfer in IT projects exist. Furthermore, there are few empirical studies measuring and explaining IT project success. This seems to be a paradox, as the importance of knowledge grows rapidly in most IT projects. The target group of this study includes project personnel, IT executives, and researchers.

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Factors Affecting Knowledge Transfer

The concept of knowledge is clearly distinct from information. In this article we regard information as the fundament of knowledge, meaning it can be associated with facts about the real world. Knowledge is information combined with experience, context, interpretation, reflection, intuition, and creativity. Knowledge can be seen as the capacity, embodied in the brains of people and embedded in social practices, to interpret information, transforming it into fresh knowledge (Davenport and Prusak, 1998). Embodied in language, stories, concepts, rules, and tools, knowledge results in an increased capacity for decision-making and action to achieve a specific purpose. This knowledge then becomes information again once it is articulated or communicated to others in the form of text, computer output, spoken or written words, or by other means. Several categories of knowledge exist: tacit, explicit, embodied, encoded, embrained, embedded, event, and procedural knowledge (Venzin et al., 1998).

Much attention has focused on knowledge management in recent research literature. Defining knowledge management and its purpose and methods are still debated extensively. In this article we define knowledge management as a method to simplify and improve the process of creating, sharing, distributing, capturing, and understanding knowledge in a company. Knowledge management is a discipline focused on systematic and innovative methods, practices, and tools for managing the generation, acquisition, exchange, protection, distribution, and utilization of knowledge, intellectual capital, and intangible assets (Montana, 2000). The purpose of knowledge management is helping companies create, share, and use knowledge more effectively. Effective knowledge management reduces errors, creates less work, provides more independence in time and space for knowledge workers, generates fewer questions, produces better decisions, reinvents fewer wheels, advances customer relations, improves service, and develops profitability.

Knowledge transfer can be defined as "how knowledge acquired in one situation applies to another" (Singley and Anderson, 1989). Knowledge exchange can occur at various levels in an organization: between individuals, from individuals to explicit sources, from individuals to groups, between groups, within groups, and from the group to the organization. Knowledge transfer channels can be informal or formal, personal or impersonal. In management and individual psychology literature, knowledge transfer receives much attention, with several mechanisms for knowledge transfer described (Argote et al., 2000). These mechanisms include movement, training, communication and observation of personnel, technology transfer, replication routines, patents, scientific publication and presentation, interaction with suppliers and customers, alliances, and other forms of inter-organizational relationships.

Even though a growing number of executives, consultants, and management theorists have proclaimed that knowledge constitutes a major competitive advantage for organizations, many firms have not achieved their knowledge management objectives. Knowledge transfer is not a simple process. Organizations often do not know what they know and have poor systems to locate and retrieve the knowledge that resides in them. This article focuses on the following factors affecting effective knowledge transfer in organizations and projects: information technology, systems and procedures, and organizational culture.

Information Technology. IT can support all forms of knowledge transfer, but has mostly been applied to informal, impersonal means (such as discussion databases) and formal, impersonal means (such as corporate directories). One innovative application of technology for knowledge transfer uses intelligent agent software to develop interest profiles of an organization's members to determine which members might be interested recipients of point-to-point electronic messages exchanged among other members. IT can increase knowledge transfer by extending the individual's reach beyond formal communication lines. Computer networks and electronic bulletin boards and discussion groups create a forum that facilitates contact between the person seeking knowledge and those who may have access to the knowledge. Video technologies can also enhance knowledge transfer.

Systems and Procedures. Knowledge is only valuable if it is appropriate, accurate, and accessible. Successful knowledge management and transfer require systems, methods, and procedures. According to Seng et al. (2002) these systems and procedures constitute a framework for knowledge transfer, i.e., identifying what a user wants or needs to know, how knowledge should be created, collected, stored, and shared and the responsibilities for the process. This framework should also include a clear organizational plan on knowledge transfer, e.g., a procedure instructing all project managers to write an experience report at the end of the project.

Culture. Organizational culture is increasingly recognized as a factor in promoting intellectual assets. According to De Long and Fahey (2000) culture influences behavior central to knowledge creation, sharing, and use in several ways. First, culture—and subcultures in particular—shapes assumptions about what knowledge is worth exchanging. Second, culture defines relationships between individual and organizational knowledge, determining who is expected to control specific knowledge, as well as who must share it. Third, culture creates the context for social interaction that determines how knowledge will be shared in particular situations. Fourth, culture shapes the processes by which new knowledge—with its accompanying uncertainties—is created, legitimated, and distributed in organizations.

Success Measurement

Doubts often exist about which persons and criteria actually define project success. What does project success mean? Is there more than one way to evaluate project success, and should the same rule apply to all projects? Gray (2001) argues that the project success concept has been ambiguously defined in project management literature. This assessment supports Baccarini (1999), who found that a review of project management literature provided no consistent interpretation of the term project success.

Project success has traditionally been represented in triangular form, showing cost, time, and quality targets. Most project managers see their job as successfully completed when they finish the project on time, within budget, and according to specifications. However, different stakeholders (the owner, developer, users, the general public, etc.) will have different expectations of a project, so their criteria of project success will also differ. To cover all these different perspectives we have applied the success framework

suggested by Atkinson (1999). This framework, called the square root, seems to cover success criteria suggested in research literature (Baccarini, 1999; DeLone and McLean, 1992; Seddon, 1997; Kerzner, 1987; Pinto and Slevin, 1988; Wateridge, 1995). The first criterion is cost, time, and quality, which traditionally has been the easiest way to measure project success (Shenhar et al., 1997). The second success criterion is the information system, the third is benefits for the client organization, and the fourth is benefits for the stakeholder community. In this research we add a fifth success criterion, which focuses on system implementation. We apply the following five success criteria for IT project success.

Project Performance. This is the traditional evaluation criterion for project success, consisting of time, cost, and quality. The project has to be completed within the time schedule and financial budget, while the technical requirements have to be fulfilled.

Project Outcome. This measurement is concerned with evaluating the information system itself. Important dimensions include system maintainability, reliability, validity, and information-quality use.

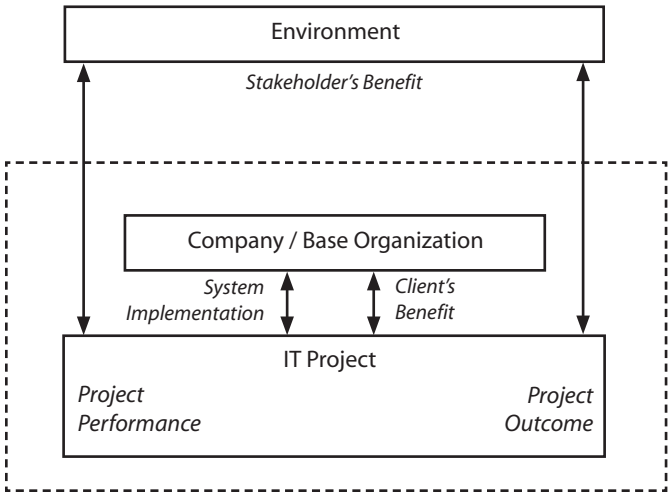
System Implementation. This criterion is concerned with successfully introducing, installing, training, using, and modifying the new information system. Important dimensions include actual use and user acceptance.

Benefits for the Client Organization. Important dimensions of this success criterion are improved efficiency and effectiveness, increased profits, achieving strategic goals, and organizational learning.

Benefits for the Stakeholders. Important dimensions of this success criterion are satisfied users, social and environmental impact, and personal development.

The five success criteria are shown in Exhibit 1. Project performance and project outcome are success criteria internal to the project. Systems implementation and client benefits are success criteria internal to the organization. Stakeholder benefits are success criteria external to the organization.

Exhibit 1. Success Criteria for IT Projects



Research Hypotheses

Many IT tools to support knowledge transfer have been developed in recent years (Ruggles, 1997). Some of these tools are based on technologies that, if correctly designed and implemented, can effectively support knowledge management (Davenport and Prusak, 1998).

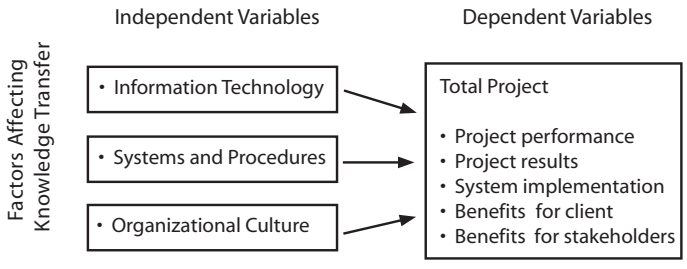
Knowledge transfer needs technology in the form of technical infrastructure, communication networks, and a set of information services. Information technology—multimedia, e-mail, intranet, and databases—enable individuals in the organization to share information from various sources. These tools also increase the speed at which knowledge can be exchanged. Many of these tools have been considered important for effective project execution. We propose the following hypothesis: ***H1:*** *Total project success is related to the extent of information technology for effective knowledge transfer.*

Systems, methods, and procedures frame knowledge transfer. This framework defines how knowledge in the organization is captured, stored, processed, and shared. Systems and procedures are the basis for successful knowledge transfer, when the IT department conducts a project and the project manager wants to benefit from the experience of others within the organization (Kasvi et al., 2003). Using systems and procedures designed for this purpose can enhance all stages in the knowledge transfer process. We assume that systems and procedures for knowledge transfer are significant for project results. We propose the following hypothesis: ***H2:*** *Total project success is related to the extent of systems and procedures for effective knowledge transfer.*

According to McDermott and O'Dell (2001), culture plays an important role in the success of knowledge management efforts. Many examples of well-designed knowledge management tools and systems failed because people believed they were sharing well enough or because senior managers did not really support them. Many IT projects could have been more successful if the organization's culture supported the knowledge transfer and sharing process. These projects often fail because: there are no incentives to promote sharing knowledge and insight among employees, little time or attention is given to identifying lessons learned from past project failures and successes, assumptions about new projects are not challenged, the organization hires and promotes individuals based on technical expertise alone, and management is reluctant to talk about projects that did not work well (Cameron, 2002). We argue that a culture that facilitates and supports knowledge transfer is vitally important for project success. We propose the following hypothesis: ***H3:*** *Total project success is related to the extent of organizational culture for effective knowledge transfer.*

Exhibit 2 shows the article's research model. The model consists of three independent and five dependent factors representing the basis for the proposed hypotheses.

Exhibit 2. The Research Model



Research Method

The present study consists of a survey conducted in Norway in 2002 investigating knowledge transfer in IT projects. The research instrument contained forced-answer questions with a 5-point Likert scale ranging from a high of 5 to a low of 1. Respondents were asked to rate the development of different factors for effective knowledge transfer in a project and the success criterion as it applies to the prevailing IT project.

A study sample of 1072 companies was selected from the members list of the Norwegian Computing Society. Based on correct address availability, 1050 questionnaires in English reached their destinations. Surveys with incomplete responses were deleted. A total sample of 71 was returned, each representing a specific project. The low response rate of 6.5% made us concerned about the non-response bias. After studying early and late responses, as well as responding industries, we have no reason to believe that there is any significant non-response bias. To examine the data for normality, skewness, and kurtosis tests have been performed, and destructive outliers have been excluded, reducing the sample to 68.

The survey instrument included 51 items. The measurement of factors affecting knowledge transfer included questions on information technology, systems and procedures, and organizational culture. The measurement of project success included questions on project performance, project outcome, system implementation, and benefits for the client and the stakeholders (Atkinson, 1999; Karlsen and Gottschalk, 2002), which were five predetermined success criteria or categories. To measure the reliability of each category of the dependent variable, a confirmatory factor analysis was employed. Descriptive statistics, t-tests, and regression analysis were used to analyze the data.

The projects in our sample were performed in a variety of industries, including banking and finance, commerce and trade, manufacturing, service, transportation, and public administration. The sample includes both projects characterized by routine work as well as research projects. The average size of each project in the sample was 16 participants (part- or full-time). Respondents were project managers or members of the project management group. The study shows that 9% of the projects were carried out within a department, 28% were performed across different departments, and 63% were organized as a new, independent, and temporary organization.

Data Presentation and Results

Exhibit 3 shows the descriptive statistics for the independent variables of factors affecting knowledge transfer, where the response scale ranged from 1 to 5 (1 = non existing and 5 = well developed). Means and t-tests (to assess the statistical significance of the difference between two independent sample means) were used to examine the data from the survey. From the exhibit we can see that IT for knowledge transfer has the highest mean score (m = 3.35). We can conclude that IT for effective knowledge transfer is significantly more developed in the studied organizations than systems and procedures. However, it is not possible to conclude that this factor is more developed than the culture for knowledge transfer.

Exhibit 3. Statistics on Independent Variables

Variable	Mean	t-values	
		2	3
1 Information technology	3.35	2.29*	1.80
2 Systems and procedures	3.13		-0.27
3 Culture	3.00		

Note: *p<.05

Five multiple item scales were used to measure the construct for the dependent variable, project success, as shown in Exhibit 4. All variables exceed 0.60 in Alpha score and hence have an acceptable reliability.

Exhibit 5 shows the descriptive statistics for the dependent variable of project success, where the response scale ranged from 1 to 5 (1 = high success and 5 = no success). Means and t-tests (to assess the statistical significance of the difference between two independent sample means) were used to examine the data from the survey. The exhibit shows that implementation of the IT system is the criterion that achieved the highest success (m = 1.92), and this success criterion is significantly more fulfilled than project performance, client benefit, and stakeholder benefit. The exhibit shows 5 significant t-values. One interesting result is that the stakeholder benefit is the success criterion with the lowest fulfillment (m = 2.33), significantly different from project outcome, system implementation, and client benefit.

Exhibit 6 shows the correlation between the independent variables—factors affecting knowledge transfer, and the dependent variables—project success criteria. The measurement of total project success includes all the five success criteria.

The results shown in Exhibit 6 indicate a significant correlation between how well the systems and procedures for knowledge transfer are developed in the organization and total project success (r = -.284, p = .027). Consistent with our expectations, total project success is also related to how well the culture for knowledge transfer is developed in the organization (r = -.286, p = .024).

Furthermore, data analysis shows that how well systems and procedures for knowledge transfer are developed in the organization correlates to project outcome (r = -.401, p = .001), systems implementation (r = -.264, p = .040), and benefits for the client (r = -.253, p = .049). Results also show that how well culture for knowledge transfer is developed in the organization correlates to project performance (r = -.301, p = .017), project outcome (r = -.383, p = .002), and systems implementation (r = -.263, p = .037). As Exhibit 4 confirms, no other significant correlations exist between the independent and dependent variables.

Three factors affecting knowledge transfer in IT projects are studied in this research. These factors can be investigated simultaneously by regression analysis. Regression analysis was used to find the extent that IT, systems and procedures, and culture explain variance in project success. Exhibit 7 summarizes regression results for each dependent variable and the main dependent variable—total project success.

Hypothesis 3 suggests that total project success relates to how well culture for knowledge transfer is developed in the organization. As we can see from Exhibit 7, a significant correlation exists between the three independent variables and the dependent variable (R^2 = .18, F = 4.216, p = .009). Culture is the only significant independent variable; hence *hypothesis*

Exhibit 4. Realiability of Multiple Item Scales

Construct	Measurement of Construct	Alpha
Project performance	Cost	0.884
	Time	
	Quality	
	Project process	
	Technical requirements	
Project outcome	Reliability	0.853
	The system works	
	Technical performance	
	Solves the given problem	
	Availability	
	Maintainability	
System implementation	Makes use of it	0.862
	Is used extensively	
	Meets its intended users' needs	
	Users' involvement in implementation	
	Minimal start-up problems	
	Users' satisfaction and acceptance of the system	
Benefits (client)	Strategic importance	0.840
	Improved performance	
	Increased efficiency	
	Increased effectiveness	
	Improved decision-making	
	Increased profit	
	Organizational learning	
	Makes desired information available	
Benefits (stakeholders)	Contributes to personal development	0.664
	Positive social and environmental impact	
	Stakeholders are positively affected	
	Improved project management skills	

Exhibit 5. Statistics on Dependent Variables

		t-values			
Variable	Mean	2	3	4	5
1 Project performance	2.15	1.91	2.43*	0.66	-1.69
2 Project outcome	1.98		0.95	-1.34	-4.13**
3 System implementation	1.92			-2.44*	-5.77**
4 Benefits (client)	2.08				-4.25**
5 Benefits (stakeholders)	2.33				

Note: *p<.05; **p<.01

3 was supported by the research. Results show that the other hypotheses were not confirmed.

When studying other dependent variables in Exhibit 5 we find a significant prediction of project outcome by systems and procedures and culture, as well as a significant prediction of system implementation in general.

We conducted additional analyses, looking at specific background variables regarding the sample of projects. No other significant correlations between factors for effective knowledge transfer and total project success were identified.

Discussion

Exhibit 8 shows the discussion of the empirical results. The independent variables are located on the horizontal axis, moving from technology via systems and procedures to culture. The other dimension in the exhibit, on the vertical axis, describes

Exhibit 6. Correlation Statistics

Dependent Variables	Independent Variables		
	Information Technology	Systems and Procedures	Culture
Project performance	-0.156	-0.156	-0.301*
Project outcome	-0.224	-0.403**	-0.383**
System implementation	-0.158	-0.264*	-0.263*
Benefits for client	0.031	-0.253*	-0.127
Benefits for stakeholders	0.185	0.058	-0.110
Total project success	-0.153	-0.284*	-0.286*

Note: *p<.05; **p<.01

Exhibit 7. Regression Statistics

Independent Variables	Dependent Variables					
	Project Performance	Project Outcome	System Implementation	Benefits for Client	Benefits for Stakeholders	Total Success
Information technology	-0.910	-0.411	-0.687	1.525	1.249	0.062
Systems and procedures	0.180	-2.014*	-0.907	-2.282*	-0.072	-1.289
Culture	-2.171*	-2.428*	-1.442	-0.545	-1.320	-2.297**
df	(3,65)	(3,65)	(3,65)	(3,65)	(3,65)	(3, 65)
R^2	0.124	0.293	0.132	0.109	0.054	0.184
F	2.646	7.753**	2.846*	2.291	1.075	4.216**

Note: *p<.05; **p<.01

project success. Project performance and project outcome are success criteria internal to the project. Implementation and benefits for the client are success criteria for the company or base organization. Benefits for the stakeholders are success criteria external to the organization.

For many managers the road to becoming a knowledge organization can be complex, frustrating, and challenging. In many situations, the best intentions, along with copious amounts of human and technical resources, are devoted to creating a knowledge-based organization with little or no results. Although the results of this research cannot address all potential challenges faced by managers in their quest to create a knowledge-based organization, it indicates a focus.

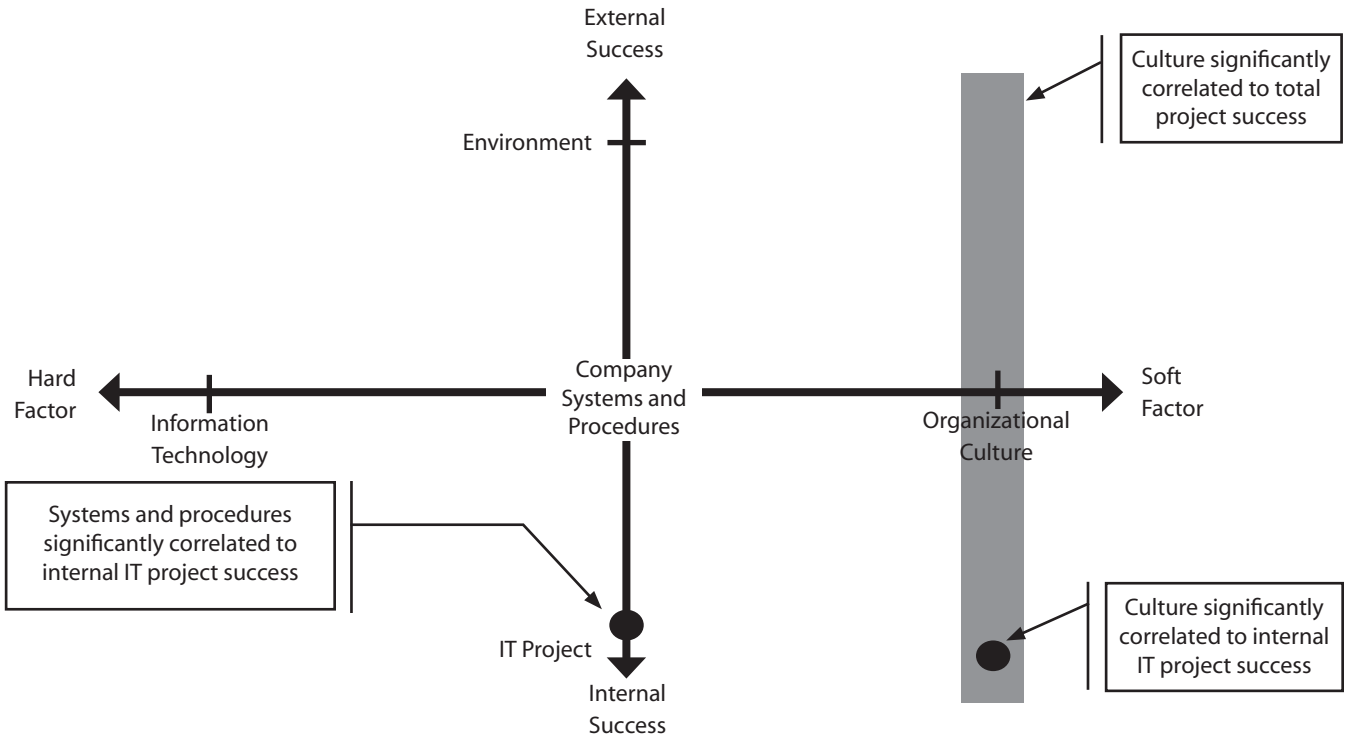
The main finding in this study positively relates total project success to an organizational culture for effective knowledge transfer. This observation is supported by several researchers who emphasize that organizational culture is perhaps the most significant factor affecting effective knowledge management (Davenport and Klahr, 1998; Davenport et al., 1998). We therefore argue that shaping a culture is central for a firm's ability to manage its knowledge more effectively. We recommend that in this culture, interaction between individuals and groups be encouraged, both formally and informally, so that those not working side-by-side, can share new ideas, experience, and perspectives. Important components of organizational culture are visions and values (Leonard, 1995; Von Krogh, 1998). To encourage knowledge growth within the organization and projects, we recommend formulating an explicit vision. To determine the types of knowledge desired and the types of knowledge related activities tolerated and encouraged, organizational values should be established and communicated. Trust and openness are two values that promote knowledge management behavior.

From the regression analysis we find a significant prediction of project outcome by systems and procedures for effective knowledge transfer. The implication of these results is that systems and procedures should be designed and integrated in the organization and projects so they can support knowledge sharing among individuals and groups.

An interesting finding is the lack of significant correlation between information technology for effective knowledge transfer and project success. During the last decade many Norwegian organizations have made large investments in technology and databases for knowledge transfer. Experience from projects in these organizations indicates that in most cases this technology for knowledge exchange is not used as intended, and consequently has no impact on project success.

Many research studies (e.g., Alavi and Leidner, 1999; Davenport and Prusak, 1998; Holsapple and Joshi, 2000) stress the importance of an organizational culture combined with information technology for successful knowledge transfers. Exhibit 8 illustrates how organizational culture alone significantly and positively affects project success. The role of information technology remains unclear. An avenue for future research would study links between information technology and organizational culture in knowledge transfer.

Exhibit 8. Factors Affecting Knowledge Transfer



Study Limitations

We are aware that this study may have several limitations. First, the low response rate of 6.5% may make it difficult to draw clear conclusions. Second, the research model may be viewed as simple. It states that a correlation exists between each of the factors affecting knowledge transfer and project success, without ranking the factors or establishing independent measures. Another limitation is that respondents who evaluated project success were project managers or members of the project management group. Other stakeholder opinions may have differed on whether or not the projects were successful.

Lessons and Recommendations

There are several lessons learned and recommendations as a result of our findings.

First, project work is based on the knowledge of individuals. Other individuals in the project can apply this knowledge successfully if it is transferred and applied efficiently and effectively. Creating a climate for knowledge transfer and mechanisms for efficient and effective knowledge transfer will enhance the project team's ability to achieve project success. Total project success depends on both systems and procedures for knowledge transfer, as well as culture for knowledge sharing.

Second, based on such research results, our recommendations to managers concern systems, procedures, and cultures. Knowledge is only valuable if accessible when needed, making it necessary for managers to develop systems and procedures. Such systems and procedures constitute a framework for knowledge transfer. Furthermore, managers have to communicate what knowledge is worth exchanging. For this purpose, managers have to create space and place for social interaction to share relevant knowledge.

Finally, management practice has to expand from people management to knowledge management. Managers should be able to intuitively identify valuable knowledge of project individuals, then recommend that other individuals ask for, internalize, and apply such knowledge. Management research should expand from human resources to knowledge management. Such research can include measurements of intellectual capital and knowledge creation.

Conclusion

According to Turner (1999), project teams consist of knowledge workers. The issue of how to transfer and share knowledge better across teams and between knowledge workers in IT projects becomes a central concern. In this article we have studied factors affecting knowledge transfer and their importance for IT project success. The factors we analyzed are information technology on the hard side, via systems and procedures to organizational culture on the soft side. Project success is measured by an evaluation of five criteria—project performance, technical results, system implementation, benefits for the client organization, and benefits for other stakeholders. By a theory analysis and empirical testing, the authors found several interesting results. Of the three hypotheses presented in the article, one was supported. Results show that total project success relates to a culture for effective knowledge transfer. Additionally, we found a significant prediction of project outcome by systems and procedures and culture, as well as a significant prediction of system implementation in total.

The results from this article can benefit both project personnel and IT executives in several ways. Overall, we recommend that more attention be given to knowledge management in IT projects and organizations. It is important that this focus

address all the various stages of knowledge management, from knowledge creation via knowledge collection to knowledge use. Many organizations tend to introduce programs and tools for knowledge management, without considering the importance of social and cultural aspects of knowledge retention and transfer. A challenge in all IT projects and organizations is considering the ways that culture influences behavior central to knowledge creation, sharing, and use. Although IT-based tools and techniques may support knowledge transfer and sharing, a lesson learned from this study is that knowledge management should not be related to information technology alone.

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